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BIOLOGY AND AGRICULTURE IN THE POSTWAR WORLD[1]

By Dr. ROBERT F. GRIGGS
NATIONAL RESEARCH COUNCIL

BIOLOGISTS have not measured up either to their opportunities or to their responsibilities in contributions to the war effort. It is highly important for the public welfare and for the welfare of biologists that this situation be improved. There are many clear signs that the biological arts and sciences are going to assume a much more important role in public service than they ever have before. It is important that we biologists be able to perform this increased service that we should be rendering.

For the first time in history food is being used as an instrument in national and international policy. Food policy as it is now being formulated by the Interim Commission of Food and Agriculture set up by the Hot Springs Conference of the United Nations is the best device yet brought forward for preventing future wars.

How far the recommendations of the Interim Commission will be put into practice it is not now possible to say. But I believe it certain that some sort of food policy will be adopted by the civilized nations. Some policy will in fact have to be adopted. Food production in the United States has increased much more than in the first World War. It is up about one third over 1939. It has increased even more in Britain. There is good reason to suppose that further increases rather than recessions will occur. We shall have food surpluses—if we are to consider them surpluses—much greater than during the depression. In the face of the situation that is surely coming only two courses are possible: (1) we may either restrict production and put surplus producers on some sort of a

[1] Invitation paper before a joint session of Section G and the Botanical Society of America in Cleveland, September 13, 1944 (somewhat revised).

dole, or (2) we may dispose of the surplus at low prices. There are many millions of people who never get enough to eat who need all the food that can be produced. How can the food be got to them? To do so we need to make only one simple decision which is analogous to a decision made by our forefathers here in America.

In the old days only the well-to-do could afford an education. Our forefathers decided that it was necessary for the public good that every child go to school. If now we similarly decide that it is in the public interest that everybody have enough to eat, food will be provided for all.

As I pass to the more personal problems of our group, I point out that the servicing of any food policy whatever is going to call for great enlargements in the biological and agricultural sciences.

Now at the threshold of the postwar world, we must ask ourselves what kinds of professional services will be rendered by the group which we loosely call biologists. Clearly enough we have not done very much in the war. The most striking feature of the whole war effort from the point of view of biologists is the fact that we were not enabled to render anything like the services which were needed and which we were anxious to give toward the war effort. Why was this so?

The essence of professional service is that it should provide what clients need—not necessarily what they want. Clients are acutely conscious that they need help, but they seldom have any clear conception of what they need from any of the professions. That is one's primary reason for calling a doctor. All that is required of a patient is that awareness of need prompt him to consult a doctor. A competent physician will do the rest.

Here is the first of our problems. We must educate the public, of which the Army is part, to realize what it needs from us. The Army had need of a vast amount of service from our sciences, but it wanted very little.

That is always the way with the Army, or, for that matter, with any organization. More than a year before the "bazooka" appeared in North Africa a friend told me that his organization was developing a portable weapon carried by two men which would do the damage of a cannon which had to be mounted on an automobile truck. But, said he, "The Army will have none of it." We all know the outcome. When the Army was finally convinced and took it up they were inordinately proud of it. Perfecting the weapon required perhaps less work than "selling" it to the Army. Educating the Army to its own need is a major part of war service.

We scientists do not generally appreciate that this is a perfectly expectable characteristic of human nature. You will recall the well-known occasion when George Westinghouse tried to sell air brakes to Vanderbilt, and the railroad magnate dismissed him with the remark that he "had no time to bother with damn fools." We who number so many teachers among us ought to know that education is a slow, difficult process which requires an expert staff, a systematic curriculum and careful organization throughout.

Why should we expect it to be different with the War Department? The thing to rejoice in and marvel at is not that new weapons were invented but that O.S.R.D. had the set-up and the funds to carry its ideas clear through to the battlefield.

Many important improvements in warfare were offered by the plant and animal sciences, but our groups did not have the organization to carry through or even to get the funds necessary to carry through.

I am reliably informed that $500,000 was spent for development work on a fungus project which could have been done by mycologists for $20,000, but the government agency in charge did not know where to turn for assistance. If one were to try to allocate blame for this waste he would have to charge it not to the government, but to the patriotic mycologists who though anxious to help did not know that a professional organization was necessary to render effective assistance. If there had been a competent war committee in mycology, alert and able to give the time required to establish the necessary contacts and confidence in the competence of their "profession" the mycologists would, as they should, have made a tremendous contribution to the war and would have secured a recognition of the importance of their science, which is still a long way off.

It is interesting to observe that the plant pathologists, who deal with fungi as do the mycologists, but in a more limited way, could not handle the problem in question. They were in fact not aware of it until it was well on its way toward solution.

Yet the plant pathologists, together with the entomologists, had a very able war committee on crop protection which did one of the best war jobs in the whole field of the life sciences. Their committee, cooperating intimately with WPB, worked out a system of allocations and substitutions which provided an adequate supply of fungicides and insecticides through the period when all copper was sequestered for war uses. As an illustration of the amount of persistent education that was necessary to bring that about it is interesting to recall that on the first interview WPB replied, "Oh, yes, we recognize that you must have insecticides and we will give you all the blue vitriol you need. But of course every ounce of copper will be used in weapons"—blissfully ignorant that blue vitriol is sulphate of copper.

A good illustration of "what it takes" to serve the War Department, or for that matter any part of the

public, is furnished by the Ethnogeographic Board. That board, headed by Duncan Strong, undertook to furnish the War and Navy Departments with all available information from travelers and from the literature about the geography, the peoples and the conditions in countries of interest to the military. It proceeded both to gather together all possible resources and aggressively to contact all officers in the Armed Forces responsible for furnishing this type of information to the field commanders. It won great acceptance and high appreciation from the Services, as it deserved to do. But it required a good many thousand dollars just to make available to the Army what was more or less common knowledge to the sciences concerned.

The devotees of the biological and agricultural sciences may, I believe, usefully consider the education of the public which has been carried out by the medical profession during the last generation. When I was a boy nobody thought of calling a doctor until he was bedfast. The result was that in many cases the doctor was not called until it was too late.

By a long and carefully planned course in public education the physicians have shown us that it is thoroughly advantageous for us to seek help from them at the first sign of trouble. This has been of even greater advantage to physicians than to patients. The change in the situation of the medical profession is very great, and very important for us to consider.

First and most important is that fact that the public is being maintained in far better health than was possible under the old régime. That is to say, the foundation of all the prosperity of the medical profession lies in the fact that it is rendering better service than it ever did before. Second, under this growing appreciation of our general need of medical attention, the number of physicians has doubled and quadrupled, and their average incomes likewise have doubled and quadrupled.

Clearly the job of the biological and agricultural sciences is similarly to educate the public as to what it needs in the way of service in our fields.

What biological services, now, does the public need? Very much as the old-time doctor could not have foreseen the services which his successors would render, so we in our sciences have no very clear vision of what we ought to be doing for the public. That, I think, is our greatest weakness, and every one of us ought to set his mind to work figuring out those ways in which in his specialty he could contribute most to the public welfare.

I shall content myself with only one illustration of what I mean—drawn from my own science, ecology. The ecology—the total ecology—of pastures and ranges is a matter which has been given comparatively little attention. It has been computed that in some of the western ranges the rodents consume more forage than do the grazing livestock. The insects may take as much as the rodents and domestic animals combined.

All the complex interrelations of forage plants, rodents, insects, predatory animals and domesticated livestock in pastures and ranges call for detailed and expert attention by large groups of specialists. At present there are no such people. We have plant ecologists who will study succession of vegetation on the pasture, and we have animal ecologists who will discuss the relations of the various animals present—but we have no adequate and comprehensive knowledge of the total ecology of pastures.

Moreover, all our knowledge of pasture ecology is general or, at least, it is expressed in generalizations. What is needed is very specific service on specific ranges at specific times.

Suppose for the sake of illustrating the point that our present knowledge of pasture ecology were an adequate foundation for management of pasture lands. We would be merely in the stage of progress where research could begin to be useful. In medicine the utilization of a research begins only after its publication when it is taken up and put into practice by physicians. But in ecology we drop a subject when we have successfully completed and published the pioneer research.

We ecologists naively hope that farmers and ranchmen will apply the findings of ecological research to their own lands. But no one would expect that laymen could go far in the application of the results of medical research to their own ailments.

One can readily name half a dozen other types of practicing ecologists whose service to the public would be decidedly worthwhile. Every ocean-going fishing vessel should carry an ecologist thoroughly grounded in oceanography. As it is now, the captain has to be ecologist as well as navigator and executive. Similar specialists in game management are needed in every considerable game-producing area. Consulting specialists in the control of soil erosion are needed in many areas fully as much as physicians to maintain the very existence of man on those lands. Billions of dollars would be saved annually by the services of a competent corps of farm management specialists available to individual farmers. Our present extension system provides only a minute fraction of the services needed, that is to say, of the services which would return to the landowner substantially more than it would cost to provide them.

It is important to realize that our professions would grow and prosper irrespective of whether such services were provided on a fee basis, as are physicians and lawyers, or from public funds, as are county

agents. There are advantages and disadvantages of each type of compensation for the consultants. The relative merits of these systems do not enter into our present concern. The important consideration for us now is that the public welfare would be vastly promoted by the development of ecological services of the type mentioned.

One type of such practicing ecologist is already in existence though in a small and comparatively inadequate way—the forester advising those types of forest management that will bring the largest returns in the long run. What ecologists need to do is to take organized thought toward the development of similar avenues of service in other branches of the science.

Ecology is merely an example. Every other biological and agricultural science has similar calls for service and every one ought to have an energetic promotion committee to bring to realization its opportunities—no, rather, its duties—to serve the public.

In the biological sciences we have no considerable body of men comparable to the practitioners of law and medicine, and among practitioners I include in this sense the lawyers and physicians who are supported by public funds as well as those who set their own fees. It is we, in fact, who deserve the familiar jibe leveled at a proverbial Mexican Army. At present we are all trying to be generals!

We complain that whereas medical research is generously supported, research in the biological sciences receives only niggardly stipends. It is often said that the difference is due to the directness of application of medical research to human welfare. This can not be the real reason, for much research in the biological sciences brings as direct benefactions to its recipients as the services of a physician. Hybrid corn, enabling a man to produce 30 per cent. more with the same effort than he could with the old varieties, certainly confers as direct a benefit as the physician who by his advice might perhaps be able to keep the farmer well, actively producing and out of the poorhouse for, let us say, 30 per cent. more years than his father. But the services which plant and animal breeding can render to agriculture and through agriculture to all of us have yet to be imagined by most people.

I believe that the better support of medical research is due more to the fact that there is a large body of physicians able to understand technical researches and to interpret them to the public than to any other reason. Certainly the American people will support biological researches as soon as they are convinced of what these will do for human welfare. The best way to gain support for research in the biological sciences is to develop a large body of intelligent and influential practitioners who would demand that some one solve the problems they met in their daily service.

An unsympathetic but, I fear, discerning critic has charged that while the chemists, physicists, geologists and other scientists have gone to work in the service of mankind, the biologists are still children picking flowers and catching butterflies!

Psychology, the latest science to join the group practicing directly for the public, has achieved that degree of service only during our generation. I would call your attention to the twin facts that the public now finds very useful, psychological procedures of which it was entirely ignorant a few years ago, and that psychologists at the same time have become more numerous, better paid, more useful and, may I add, they have developed vastly greater self-respect than they had a generation ago. Moreover, the pure science of psychology has made such progress in these decades as could not have been imagined by our fathers.

The problem before us, then, is to create more jobs in the biological sciences by enlarging their services to the public welfare. This is not a thing which can be done in a day but requires continuous effort and calls for a never-ending program of public education.

Our scientific societies ought to undertake it. Consider how long the physicians have been engaged in this sort of activity, and how it continues to pay dividends both to the public in the way of longer and better living and to physicians in opportunities for more service.

The primary need of our sciences is for permanent organizations of skilled people to carry on this work of public education. I believe that biological and agricultural scientists could make no better investment than to supply the funds for such organization.

People tell me that the income of biologists is too small to permit them to assume the expense of effective organization. I reply that just because they are underpaid, biological scientists need all the more to undertake this work. It is the one thing which they can not afford to skimp.

I will admit, however, that permanent effective organizations are more than some of our scientific specialties could undertake, and the obvious answer is for related fields to combine for this purpose. We have among us illustrations of the beginnings of such combinations of societies. One is the Federation of American Societies for Experimental Biology. A second is the Inter-Association Council of Societies Concerned with Animal Disease and Production. Other areas in which combination is obviously called for are in the fields of plant disease and plant protection in which the plant pathologists and entomologists could well develop their common services to the ad-

vantages of themselves and the public. Another is the various societies concerned with the other manifold applications of ecology to the public service, which are suggested in the illustration given above.

Now, as I talk, I suspect that a large number of my audience are feeling that I am not talking about them or even that I am not talking about biology as they know it, since I have spoken only of applications. The majority of you—of biologists in general—are teachers, as I am myself. We are devotees of pure science and we commonly look down on applied science. And that is the way I also was brought up. But we are acutely conscious of the fact that there is no adequate outlet for the students we produce. This, under present circumstances, is inevitable except in special cases.

Can you imagine the majority of lawyers, physicians or engineers being teachers?

The function of the teacher in those fields is merely to train the recruits necessary to keep the professions up to strength. It is perfectly clear that the biological sciences can never grow and prosper until they develop services to the public comparable to the other professions. And when this is done the numbers who will be required for teaching will increase to proportions little dreamed of to-day. Even for the men, therefore, who love pure science and desire to devote themselves to it, opportunities will greatly increase when we develop our services to the public. Think what has happened in psychology.

The fact that so high a proportion of the devotees of the biological sciences are teachers is merely another way of saying that we have not arrived at the status of professionals.

There is no such thing as a profession of biology. Within the Division of Biology and Agriculture of the National Research Council there are, indeed, already two well-developed professions. Each has a well-marked esprit de corps. Each maintains the type of professional organization which I advocated above, and each renders valuable services directly to the public: namely, the foresters and the veterinarians.

Any thoughtful consideration in the light of fact makes it clear that there can not be any one profession of biology, that professional development in our field must come in the various segments of biology.

There is clearly room for a profession of bacteriology, of ecology, of farm management, etc.

This brings me to the question which I suspect the sponsors of this program expected me primarily to consider: namely, What can be done toward the consolidation of biology and agriculture?

All analysis makes it clear that progress must be made primarily by those different groups among us which will ultimately develop into professions. For twenty years attempts have been made to build all biologists together into some sort of a single unity. As you know very well, they have not achieved any notable degree of success despite much effort by devoted men in that cause.

The reasons for the failure are clear enough. In essence, there is not now the foundation necessary on which to build such a federation of all the biological sciences. That is not to say that there is not need for and a place for common action of all our biological groups.

I find that the National Research Council can be of use, separately, to foresters, veterinarians, agronomists, bacteriologists, soil scientists and so forth, but it has to serve these different groups alternately. Their interests, their techniques and their objectives are too diverse to permit them to work together in common assembly.

We could not set up any single War Committee in Biology and Agriculture. There was plenty of good-will and no jealousy to interfere. But every problem that came up was concrete and called for consideration by experts in one segment of our field only. For instance, dairymen could not help much with the development and allocation of insecticides any more than plant pathologists could help with strictly mycological problems or foresters with problems in nutrition or bacteriologists with the shortage of animal feed.

If I may revert to an analogy used on a previous occasion,[2] I fear that we, who have been concerned with cultivating the growing plant to which we may liken the tree of the biological sciences have made the error, commonly fallen into by inexperienced gardeners, of looking only at the top of the tree we are seeking to nurture without paying sufficient attention to the roots. In short, our biological sciences are not as yet well enough rooted in service to the public to support the type of organized federation which we would all like to see.

Any serious examination of the roots of the biological tree will, moreover, reveal, I believe, that it is not growing from one tap root but has, rather, a branching root system spreading in many directions. Our present concern should be to strengthen each of these various roots, particularly those which show signs of vigorous potentiality and those which are reaching into large areas of unoccupied ground. If this is done, and not before, I suspect the top of the tree will blossom forth in a Federation of all the Life Sciences that would be surprisingly satisfactory to those who recognize the essential unity of all living things.

[2] SCIENCE, 96: 2503, 545–551, December 18, 1942, Vol. 96, No. 2503, pp. 545–551.

OBITUARY

SUMNER A. IVES

DR. SUMNER A. IVES, a native of Maine, spent most of his life as a teacher of biology in liberal arts colleges of the South. He took his undergraduate work at Wake Forest College, and then went to the University of Chicago for the B.S., M.S. and Ph.D. degrees. While professor of biology at Howard College Dr. Ives helped to organize the Alabama Academy of Science in 1924, and became the first secretary, treasurer of that body. On coming to Furman University he maintained his interest in the academy movement, serving the South Carolina Academy of Science in a number of offices, including that of president.

Dr. Ives gave freely of his time and talents to the communities in which he lived. His professional knowledge was much sought after by the garden club of Greenville; the members of this organization showed their appreciation of his never-failing interest by dedicating their 1945 year book to him.

Dr. Ives was not only in complete sympathy with the program and ideals of the denominational colleges in which he taught, but he was for years a teacher of Bible classes for young people and a deacon and leader in his local church. His death on December 18, 1944, is mourned by countless friends in many walks of life. He is survived by his widow, Mrs. Gladys Sharp Ives, a son now in Australia, and two daughters.

JOHN R. SAMPEY, JR.

FURMAN UNIVERSITY

RECENT DEATHS

DR. S. JOSEPHINE BAKER, from 1908 to 1922 director of the Bureau of Child Hygiene in the Department of Health of New York City, died on February 22 at the age of seventy-one years.

DR. CAROLINE BEAUMONT ZACHRY, director of the Bureau of Child Guidance of the Board of Education of the City of New York, died on February 22 at the age of fifty years.

SCIENTIFIC EVENTS

THE PROPOSED ORGANIZATION OF SCIENTIFIC RESEARCH IN INDIA

ON the invitation of the Government of India, Professor A. V. Hill, M.P., secretary of the Royal Society, spent last winter in that country to investigate and report on the position of scientific research and teaching. This was followed by the visit to Britain last autumn of five eminent Indian scientists as guests of the Government. Professor Hill's report has been published in India and a summary has been issued by the India Office and published in *The Times*, London. *The Times* writes:

The word "essential" figures largely in the report. It is first applied to the need for close scientific technical liaison between Britain, America, and the Dominions. To this end an Indian Scientific Office should be set up in London with specialists in agriculture, engineering, defence, industry, and medicine. Representative Indian scientists should be attached to the British Commonwealth Scientific Office in Washington. Young Indian teachers, research workers, and members of technical staffs must be provided with facilities for advanced studies abroad, especially in Britain.

The report dwells on the need for better statistical data; for extending "the present excellent work" on agricultural research; for making better known through the Geological Survey, etc., the great natural resources of India; and for industry to keep well ahead with scientific research and technical development.

Professor Hill makes detailed proposals to meet the need for a proper scientific organization of research for the fighting services, not only for the present war but also for the future, when a self-governing India must maintain security from aggression.

The report recommends the setting up of a Central Organization for Scientific Research, under a Minister without ordinary departmental duties, assisted by six boards. Each board would have a director as secretary and principal administrative officer, who would be *ex officio* a member of the other five boards.

India requires a central scientific academy comparable with the Royal Society of London. The best suited body for this purpose is the National Institute of Sciences of India. The Government of India should assist the specialist scientific societies in various ways without diminishing their independence.

Scientific research in universities is the basis of scientific progress. A carefully thought-out national policy with regard to grants to universities is necessary. Medicine, biology, and geology particularly need development.

Research should not be solely dependent on Government support, but should have independent resources and an independent existence. Private benefactions endowing scholarships, studentships, and research fellowships are urgently needed in India.

THE INCOME OF PROFESSIONAL CHEMISTS

THE income of professional chemical workers increased from 14 to nearly 80 per cent. at different income levels during the war years 1941–43, according to a survey conducted by the Committee on Economic Status of the American Chemical Society in

cooperation with the U. S. Bureau of Labor Statistics. The report was prepared by Andrew Fraser, Jr., of Washington, D. C. The survey, analyzing 23,011 replies from 32,861 questionnaires sent to members of the society, indicates that chemists are confident in regard to postwar employment prospects. Those replying have been divided into three major fields—chemistry, with 16,248; chemical engineering, with 5,370, and "all other fields" with 1,374.

In 1941, without regard to age, the median annual income—the level at which 50 per cent. earned more and 50 per cent. earned less—was $3,097. In 1943 it was $3,984, an increase of 28.6 per cent. One tenth of the members earned annual incomes of less than $1,388 in 1941, but in 1943 this had risen to $2,492, an increase in this lowest bracket of 79.5 per cent. One quarter of the members earned less than $2,146 in 1941, but by 1943 this had increased 43.6 per cent. to $3,082. The 25 per cent. with 1941 incomes of over $4,615 earned $5,475 in 1943, a gain of 18.6 per cent., and the 10 per cent. with 1941 incomes of more than $7,574 earned $8,625 in 1943, an increase of 13.9 per cent. The figures show that earning capacity increases with age at all five earning levels reaching a maximum at approximately 60 years of age. In 1943, the median (50 per cent. level) curve advances from a beginner's income of $2,172 a year to $6,436 a year for members who had had 28.5 years of professional experience. At the 25 per cent. income level, the advance in earnings over the same period was from $2,459 a year to $10,167, annually, while at the 10 per cent. income level the advance over this span of years was from $2,976 to $17,258.

The questionnaires show that employment opportunities for members of the society are concentrated in the Middle Atlantic Region, 33.8 per cent., and in the North Central Region, 23.7 per cent. Among high employment states are New York with 14.8 per cent. of those replying, New Jersey with 10 per cent., Pennsylvania with 9.8 per cent., Illinois with 8 per cent., and Ohio with 7 per cent.

More than 80 per cent. were employed in 1943 by private firms, educational research or consulting organizations or by other non-public sources. Of the 17 per cent. employed by public sources, 6.5 per cent. were employed by state governments and 7.9 per cent. by the Federal Government. Of those in private employ in 1943, 95.3 per cent. were engaged in manufacturing industries, and the remainder in mining, transportation, communication and public utilities. Roughly 85 per cent. of those replying stated that they had permanent employment, and 94.4 per cent. that their training was being utilized in their work.

In draft status, 31.6 of those replying were classified as draft-ineligible males, 839 or 3.6 per cent. were women civilians, and 49.4 per cent. reported they were occupationally deferred due to their professional contributions to the war. There were replies from 1,199 members already in the armed forces, but many other members who now are in service have temporarily been removed from membership lists.

THE NUTRITION FOUNDATION

A REPORT covering the three years since its founding in 1942 has been issued by The Nutrition Foundation, Inc., which was established under the presidency of George A. Sloan by the food industry of the United States and Canada for the support of independent research and education in the science of nutrition.

It is reported in this official statement that the research program of the foundation is being developed and subsidized in six different but related areas.

First, to find the basic human food requirements in terms of individual nutrients such as proteins, vitamins, minerals, etc. Ten studies are being supported, for which $70,900 has been appropriated. Funds have been placed at the disposal of Dr. W. C. Rose, of the University of Illinois, for a study of the human requirements of the amino acids and other nutrients.

Second, to learn how the individual nutrients are formed and how they function in living cells. Twenty-nine studies are in progress, for which $189,900 has been appropriated.

Third, to give special consideration to the nutritional requirements during pregnancy, lactation and infancy. Six studies have been undertaken, for which $41,000 has been appropriated.

Fourth, to unravel some of the more immediate relations between food intake and health. Eighteen studies are being made for which $135,850 has been appropriated.

Fifth, to assist in educational and applied aspects of the problem of getting people to eat the foods that will give buoyant health. Six projects are being carried forward for which $65,500 has been appropriated.

Sixth, to render every possible aid to the winning of the war. Twenty-nine studies are in progress for which $152,840 has been appropriated. In making grants with military aspects as a primary consideration, close collaboration has been maintained with the Office of the Quartermaster General and the Office of the Surgeon General.

The foundation publishes each month *Nutrition Reviews,* the object of which is to give a critical, unbiased review of literature in the science of nutrition.

ST. LOUIS CONFERENCE ON GENE ACTION IN MICRO-ORGANISMS

A SYMPOSIUM was held at the Missouri Botanical Garden, St. Louis, on February 2 and 3. Approximately forty people attended the sessions, about half this number being from the St. Louis area. The papers, with a summary of the discussions that followed them, will be published in the April issue of the *Annals* of the garden.

Chairmen of the different sections were: Dr. L. J.

Stadler, University of Missouri; Dr. C. F. Cori, Washington University School of Medicine; Dr. A. H. Sturtevant, California Institute of Technology; Dr. J. W. Gowen, Iowa State College; Dr. A. D. Hershey, Washington University School of Medicine.

The speakers included Dr. C. C. Lindegren, Washington University; Dr. G. W. Beadle, Stanford University; Dr. E. L. Tatum, Stanford University; Dr. M. Demerec, Carnegie Institution of Washington; Dr. S. Spiegelman, Washington University School of Medicine; Dr. A. Hollaender and Dr. J. P. Greenstein, U. S. Public Health Service; Dr. T. M. Sonneborn, Indiana University; Dr. M. Delbruck, Vanderbilt University; Dr. Salvatore Luria, Indiana University; Dr. Sterling Emerson, California Institute of Technology, and Dr. J. W. Gowen, Iowa State College.

There were various exhibits and demonstrations during the meeting.

SCIENTIFIC NOTES AND NEWS

THE doctorate of laws was conferred on Dr. Edwin G. Conklin, professor emeritus of zoology at Princeton University, on the occasion of the winter graduation ceremonies on February 22.

PROFESSOR CHARLES F. BROOKS, director of the Blue Hill Meteorological Observatory of Harvard University, was feted at the celebration of the twenty-fifth annual meeting of the American Meteorological Society held at Kansas City on January 24, 25 and 26. Professor Brooks organized the society at the meetings of the American Association for the Advancement of Science at St. Louis in December, 1919, and has been its secretary for twenty-five years.

THE Lamme Medal for 1944 of the American Institute of Electrical Engineers, conferred annually on a member of the institute in recognition of "high achievements in the development of electrical apparatus or machinery," has been awarded to Soren H. Mortensen, chief electrical engineer of the Allis-Chalmers Manufacturing Company, Milwaukee, in recognition of "his pioneer work in the development of self-starting synchronous motors and for his contributions to the development of large hydraulic and steam turbine driven generators."

THE Joseph A. Capps Prize for Medical Research of $400 of the Institute of Medicine of Chicago has been awarded for 1944 to Dr. James A. Roth, of the Medical School of Northwestern University, for his investigation on "The Effect of Caffeine on the Stomach."

DR. STEPHEN S. VISHER, professor of geography at Indiana University, has been elected a Jane Smith life member of the National Geographic Society "in recognition of outstanding services as a teacher of geography and notable publications on soil surveys and climatic and economic geography."

DR. CHARLES-EDWARD AMORY WINSLOW, Anna M. R. Lauder professor of public health and chairman of the department of Yale University, will retire at the end of the academic year after serving for thirty years. Succeeding him as department chairman will be Colonel Ira V. Hiscock, SC, AUS, professor of public health, now on leave of absence, who is serving as chief of the Public Health Section of the Civil Affairs Division of the War Department.

DR. JOSEPH TRELOAR WEARN, professor of medicine at Western Reserve University, has been appointed dean of the School of Medicine. He succeeds Dr. Torald H. Sollmann, who retired last year on July 1.

DR. SIDNEY J. FRENCH, professor of chemistry at Colgate University, Hamilton, N. Y., has been appointed to the newly established post of acting dean of faculty.

BRIGADIER GENERAL JAMES S. SIMMONS, chief of the Preventive Medicine Service of the Office of the Surgeon General, U. S. Army, is non-resident lecturer for the year 1944–1945 at the School of Public Health of the University of Michigan.

DR. GEORGE P. CHILD, assistant professor of biology at Amherst College, has resigned to become F. B. Stearns fellow in pharmacology at the Medical School of the University of Georgia.

DR. W. E. HANFORD, research chemist, assistant director of research of the General Aniline and Film Corporation at Easton, Pa., has been appointed manager of the central research laboratory of the company.

DR. FRANK M. SURFACE, coordinator since 1943 of sales research, has been made executive assistant to the president of the Standard Oil Company of New Jersey.

THE following appointments have been made to the British Colonial Products Research Council: J. C. Fryer, secretary of the Agricultural Research Council, in succession to the late Dr. W. W. C. Topley, and Professor H. V. A. Briscoe, head of the department of inorganic and physical chemistry of the Imperial College of Science and Technology, in succession to the late Sir John Fox, government chemist.

DR. J. F. C. CONN, senior scientific officer of the Ship Division of the British National Physical Labora-

tory, has been appointed naval architect of the British Shipbuilding Research Association.

DR. JAMES G. NEEDHAM, professor emeritus of entomology and limnology at Cornell University, is spending the months of March and April at the Archbold Biological Laboratory at Lake Placid, Fla., doing ecological work on Florida dragonflies and other aquatic insects.

STANLEY F. MORSE, agricultural consultant since 1916 with private practice in the United States and Latin America, previously state director of agricultural extension and professor of agriculture at the University of Arizona, is now chief of the American Food Mission, U. S. Foreign Economic Administration, to French North Africa. He has been serving also as chief of the Food Division of the North African Joint (Anglo-American) Economic Mission. His address is Box 861, Winter Park, Fla.

IT is reported in the daily press that Professor Frank G. Haughwout and Mrs. Haughwout have been released from Santo Tomas prison in Manila, where they had been interned since 1942. From 1919 until his retirement in 1927 Mr. Haughwout held the position of protozoologist and head of the section of parasitology of the Bureau of Science of the Philippine Islands.

DR. ROY GRAHAM HOSKINS, research associate in physiology at the Harvard Medical School and director of the Memorial Foundation for Neuro-Endocrine Research, Boston, and of the Worcester State Hospital, has been appointed Salmon Memorial Lecturer for 1945. The title of the series is "The Biology of Schizophrenia." The lectures will be given at 8:30 P.M. at the Academy of Medicine, New York City, on the evenings of November 2, 9 and 16.

DR. EDWIN COWLES ANDRUS, associate professor of medicine at the School of Medicine of the Johns Hopkins University and chairman of the committee on medical research of the Division of Medicine of the Office of Scientific Research and Development, gave on February 20 the annual Walter L. Niles Memorial Lecture at the Cornell University Medical College. He spoke on "Wartime Medical Research."

DR. EDWIN B. ASTWOOD, assistant professor of pharmacotherapy at the Harvard Medical School, will deliver the sixth Harvey Society Lecture of the current series at the New York Academy of Medicine on March 15. He will speak on the "Chemotherapy of Hyperthyroidism."

THE fourth Edwin R. Kretschmer Memorial Lecture of the Chicago Institute of Medicine will be delivered at the Palmer House on April 27 by Dr. William Bloom, professor of anatomy at the School of Medicine of the University of Chicago. The subject will be "Experiments on Hematopoiesis."

ONE hundred and fifty members of the staffs of the Shell Development Company in the San Francisco Bay Area, who are members of the Society of the Sigma Xi, have organized the Shell Development Research Club, with principles, objectives and qualifications for membership identical with those of the society. The petition of the club for affiliation with the national organization was granted last December and the formal ceremony will take place on March 21 at the Hotel Claremont in Berkeley. Professor George W. Beadle, of the department of biochemistry, Stanford University, has been designated by Sigma Xi to be their installing officer. At the same time one hundred and fifty local members of the club will be initiated. The address of the evening will be delivered by Professor William H. Wright, of the Lick Observatory, University of California.

THE meeting of the Society for the Promotion of Engineering Education that was planned to be held at St. Louis from June 21 to 24 has been cancelled in compliance with the request of the War Committee on Conventions of the Office of Defense Transportation.

AT the February meeting of the Instrument Society of Washington, L. F. Crabtree, of the Automatic Electric Company, spoke on "The Design and Application of Electromagnetic Relays," illustrated with diagrams and design charts. An informal communication on "The Design of Corrugated Diaphragms" was presented by Dr. W. G. Brombacher, chief of the Aeronautic Instruments Section of the National Bureau of Standards. The first issue of the news letter of the society, which has now more than two hundred members, was distributed during the month. At the next meeting to be held on March 20 at 8:00 P.M. in the Interior Department Auditorium, 18th and C Streets N.W., Washington, D. C., F. A. Tompkins, of the Eastman Kodak Company, will speak on "The Use of Photographic Recordings in Instruments."

THE Charles E. and Emma H. Morrison Fund of $1,750,000, bequeathed to Northwestern University by the late Mrs. Emma H. Morrison, has been used to establish four professorships. These include a professorship in zoology and a professorship in pathology.

THE Cleveland Health Museum has received authorization from the Colombian Government to duplicate seventy-three units of its exhibits, to be used as a traveling health exhibition in Colombia. Among the duplicates, which will be captioned in Spanish and will occupy an area of two thousand five hundred square feet, are exhibits on preventive dentistry, tuberculosis,

the conservation of hearing and of eyesight, the general biology of the human body and a complete duplicate of the nutrition exhibit "Food for Health."

THE Ordnance Distinguished Service Award has been granted to the Case School of Applied Science. The presentation took place at an all-college convocation, on October 20, and the presentation address was given by Brigadier General A. B. Quinton, Jr., chief of the Detroit Ordnance District Office, representing Major General G. M. Barnes, chief of the Research and Development Service of the U. S. Ordnance Department. This award is in recognition of the work of the department of metallurgical engineering, particularly for the work carried forward by Dr. George Sachs, professor of physical metallurgy, as technical supervisor. His work and that of a group of graduate assistants was carried out with the cooperation of the Frankford Arsenal. At the convocation an address was made on "Metals in War and in Peace," by Dr. Clyde Williams, director of the Battelle Memorial Institute and chairman of the War Metallurgy Committee.

Nature writes: "At the beginning of the war, a number of scientific men in England and France became conscious of the lack of close knowledge and contact between the science and scientific workers of the two countries. As a result, they founded in April 1940 an Anglo-French Society of Sciences to assist the removal of this lack of mutual knowledge. The society was organized in two groups, under the presidencies of Professor P. A. M. Dirac and Professor F. Joliot. The occupation of France interrupted normal proceedings, but during the occupation some members became very prominent in the French resistance movement. The liberation of France has enabled the society to hold its first conference, which was on the topic of 'The Solid State,' and was held in London on January 20 at the Society for Visiting Scientists. Professor Joliot and Mme. Irene Curie-Joliot traveled from France to take part in the proceedings, and were accompanied by Professor Wyart, Dr. J. Laval and Dr. Mathieu."

RECOGNIZING the increasing importance of the communications field, the French Government has decided to establish a modern National School of Telecommunications. Its specific function will be to connect all scientific research on this subject directly with the working industry. Modern and specialized laboratories have already been built, and it is expected that regular courses will be opened soon.

ACCORDING to *Current Science* the Council of Scientific and Industrial Research of India will divide the Laboratories of the Board of Scientific and Industrial Research into two sections—a chemical laboratory and a physical laboratory—with a view to facilitating their amalgamation, respectively, with the National Chemical and the National Physical Laboratories, the plans for which have already been drawn up. Dr. S. Siddiqui will be placed in charge of the chemical section, and Dr. Lal C. Verman will be responsible for directing the work of the physical section.

DISCUSSION

SIR ISAAC NEWTON AND THE SENSITIVE RADIOMETER

IN "Contributions from the Mount Wilson Observatory," *Astrophysical Journal,* Vol. LXIX, pp. 293–311, 1929, I described a tiny radiometer with triple vanes cut from house-fly's wings. It was used with some success to measure the distribution of energy in the spectra of the brighter stars, with the aid of the 100-inch reflector.

As first set up, in a sealed quartz tube filled to 0.2 millimeters mercury pressure with hydrogen gas, the tiny suspension, whose weight was 0.94 milligram and total moment of inertia was 290×10^{-9} gram centimeters^2, had a time of single swing of 12 seconds. But in an ill-advised moment I cleaned the outside of the quartz tube. It became electrified. The time of single swing dropped below one second and never recovered beyond 1.5 seconds thereafter, despite all attempts to discharge the electric field of force.

We have made several fruitless subsequent attempts to overcome this difficulty. My colleagues, Messrs. Hoover and Clark, used a tube painted with colloidal graphite, leaving only a small aperture clear to admit radiation. But this clear spot was sufficient to bring ruinous electric influences.

I have recently read Dr. Cajori's exhaustive historical treatment of the circumstances which led Sir Isaac Newton to defer his announcement of the law of gravitation from 1666 to 1686. He shows that Newton must have been aware in 1666 of several fairly accurate determinations of the length of 1° of the earth's circumference. Hence the generally accepted explanation of the delay, namely, that he failed to get good agreement on the moon's motion until Picard's results became known, is inadmissible. Cajori agrees with Adams, Glaisher and Turner that the real reason for Newton's delay was one of exact accuracy which might not have weighed with lesser men. The moon is so far away that any error in assigning the position of the seat of the attractive center within the earth would be negligible. But when one announces as a law that every particle of matter attracts every other particle with a force proportional to the product of their masses, and inversely to the square of their dis-

tances apart, and applies it to the attraction of bodies near the earth, then it makes a difference where within the earth the seat of attraction lies.

So it was not until about 1685 when Newton demonstrated the beautiful propositions related to attractions within and without the earth, including that of the zero force of attraction of a homogeneous shell upon any point within the shell, that he could locate the earth's seat of attraction definitely at its center. Then he was able to announce his law of gravitation.

When all our attempts to free the radiometer of the pernicious effects of electrostatic fields had failed, I bethought me of this beautiful theorem and its electrical analogue that the force within a closed conductor is zero. I suggested to my colleagues that we insert a brass tube, of rather small radius, centrally within the quartz tube which contains the radiometer. Small holes are bored through the brass tube to admit radiation and the viewing of the vanes, and another opposite the reflecting mirror. We feared, indeed, that the holes might introduce disturbance, because the shielding would be not quite complete.

To our great delight this device works favorably. No electrostatic fields we can create on the outer quartz tube seem to greatly modify the time of swing of the radiometer suspended within the brass shield. Thus Sir Isaac Newton's beautiful theorem has saved the day for the radiometer of highest sensitiveness.

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A 2,3-BUTANEDIOL-GLYCEROL FERMENTATION[1]

FORD'S strain of *Bacillus subtilis* (A.T.C.C. 2586) produces 2,3-butanediol and glycerol as the main products when grown at 30° C. on a glucose solution (3 per cent. glucose, 1 per cent. yeast extract, 1 per cent. $CaCO_3$) at pH 6.0–6.8 under anaerobic conditions. For each 100 mols of glucose fermented 57 mols of 2,3 butanediol, 40 mols of glycerol, 20 mols of lactic acid, 13 mols of ethanol and 5 mols of formic acid were found. The glycerol was isolated and identified as the tribenzoate and tri-*p*-nitrobenzoate; in each case a mixed melting point determination was made with an authentic sample. Ethanol was similarly identified as the *p*-nitro benzoate. Lactic acid was isolated as lithium lactate and identified by quantitative oxidation to acetaldehyde in boiling, dilute permanganate solution. The 2,3-butanediol was purified by distillation. Judging from its physical properties it is a mixture of the *levo* and *meso* isomers in approximately equal amounts. It was identified by bromine oxidation to diacetyl, the latter being identified by the melting point of its *bis*-phenyl-hydrazone. To the best of our knowledge this is the first time any species of bacteria has been shown to yield glycerol as a product of carbohydrate dissimilation.

[1] This work will be described more fully in the *Canadian Journal of Research.*

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IS CASTE DIFFERENTIATION IN ANTS A FUNCTION OF THE RATE OF EGG DEPOSITION?

THE problem of caste differentiation in ants has been a moot question for many years. William Morton Wheeler, in a posthumously published book,[1] describes the situation as follows:

> It must be admitted—that the brood relationship in ants is so elaborate, the difficulties of submitting it to controlled experimental investigation so great, and observations of it so conducive to conflicting "explanations" that the controversy concerning the determination of castes in these insects has persisted with little change for years. This is shown by the attitudes of the two very eminent myrmecologists, Emery and Forel. Although both were thoroughly conversant with all the relevant facts established during their lifetimes, Emery, nevertheless, remained an intransigent trophogenist throughout his career, and Forel—was as thoroughly convinced that the castes are determined in the egg.

In view of this situation it is not surprising that it is through studies of non-social groups of Hymenoptera closely related to the ants that a possible answer to the problem of caste determination has been revealed, an answer that appears to reconcile the views of Emery and Forel.

Recently several students of the Hymenoptera have made observations which suggest that the castes are determined in the egg by trophogenic means.[2,3,4]

The amount of nutriment in a normal hymenopterous egg may be either sufficient or insufficient for the complete development of the embryo. The eggs of certain endoparasitic species appear to be devoid of nutriment. In the case of the chalcidoid *Coccophagus capensis* the egg contains enough nutriment for the development of the male embryo but not enough for the development of the female embryo. The female embryo obtains the necessary additional nutriment from the host by means of a trophic membrane.[5]

[1] William Morton Wheeler, "Mosaics and Other Anomalies Among Ants." 95 pp. Cambridge: Harvard University Press. 1937.
[2] W. Goetsch, *Naturwissenschaften*, 25: 803–808, 1937.
[3] Rudolf G. Schmieder, *Ent. News*, 50: 125–131, 1939.
[4] P. W. Whiting, *Jour. Hered.*, 29: 189–193, 1938.
[5] Stanley E. Flanders, *Jour. Econ. Ent.*, 35: 108, 1942.

Even within the individual female the ripe ovarian eggs may vary in amount of nutriment. This variation appears in the deposited eggs.[6,7] In such eggs the loss in nutriment is an effect of the oosorptive or egg degenerative process. In many species of Hymenoptera, the processes of oogenesis and oosorption form a cycle. Only by ovulation, that is, passage into the oviduct, does the ripe ovarian egg escape the final effect of oosorption. In the chalcidoid *Metaphycus helvolus* the generation of an egg requires three days, its degeneration less than one day at temperatures about 80° F.[6]

Since oogenesis and oosorption, when the female is in a gravid condition, form a continuous process and since this proceeds at a relatively constant rate, the amount of nutrient removed from each egg and the proportion of nutrient deficient eggs deposited would vary with the rate of egg deposition. Schmieder[3] in a study of the dimorphism of the ichneumonid wasp, *Sphecophaga burra,* suggested that it might be the rate of egg deposition which determined which of two inherently possible lines of development was followed.

Oosorption probably is the basis of polymorphism in the ant. Differential rates of egg deposition account for the variation in size of the eggs deposited by a queen. Since it seems certain that trophic conditions in the ripe ovarian egg determine the line of development, the rate of egg deposition may determine the proportion of castes developing from any sequence of deposited eggs.

In ants, as in many of the parasitic Hymenoptera, it is probable that the sex ratio of a sequence of eggs is also determined by the rate of their deposition, provided of course, the parent female is mated.[8] In such species the higher the rate of egg deposition the higher the proportion of eggs escaping fertilization and therefore the higher the proportion of males.

It follows that if differences in the rate of egg deposition by the queen ant determine the occurrences of the various castes, the males and queens will be produced when the rate is high, that is, when the ripe eggs are retained in the ovary for a relatively short time, while the sterile female castes and associated anomalies will be produced when the rate is low, that is, when the ripe eggs are retained in the ovary for a relatively long time.

The number of eggs deposited by the queen during any given period is regulated, in part, by the number of ovarioles which make up her ovaries and, in part, by the environment, an environment which may include the several castes in varying proportions.

[6] Stanley E. Flanders, *Ent. Soc. Amer. Ann.,* 35: 251–266, 1942.

[7] Anna R. Whiting, *Am. Naturalist,* 74: 468–471, 1940.

[8] Stanley E. Flanders, *Ent. Soc. Amer. Ann.,* 32: 11–26, 1939.

The hypothesis, as here advanced, is that rate of egg deposition (in so far as it affects the nutrient content of the egg) determines caste differentiation. Although based on studies of parasitic Hymenoptera this hypothesis may prove to be a suitable "explanation" for the sequence of castes of any Aculeate colony established by a single queen. The first brood always consists of small workers, those of succeeding broods gradually increase in size, and only after the largest workers have appeared are the queens and males produced.[9]

It is significant that the bee (*Melipona* sp.) has two sharply defined female castes in spite of the fact that all members of the colony undergo uniform treatment during their post-embryonic development.[9]

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STAFFING SCIENCE DEPARTMENTS AFTER THE WAR

IN SCIENCE, for February 16, 1945, M. H. Trytten expresses forcefully the frequently heard fear that it will be difficult for universities to staff their science departments after the war because of competition with industry.

It is undoubtedly true that industry can afford to pay much higher salaries and sometimes also to provide better research facilities. I think, however, that universities need not be afraid of the future if they remain true to their traditions. They will still be able to attract first-rate scientists, not with money but by offering them time and leisure, the stimulating contact with students that forces them to revise their views constantly and to express them with clarity, the inspiring intercourse with colleagues from other faculties, physicians, philosophers, historians, sociologists, the long summer vacations that permit them to travel and continue their work in other institutions and countries, all the many imponderables that constitute what used to be called the academic atmosphere.

This presupposes, however, that universities have the courage and vision to reorganize their administrative and departmental structure and to resist trends that tend to turn them into speed-up, high-pressure schools with purely utilitarian purposes. No serious researcher will accept the position as head of a university department, if he knows that he will be crushed with petty administrative duties or with a load of routine teaching. Men should not be selected to fit a job, but the position should be made to fit a man, because it is not regulations and curricula that con-

[9] William Morton Wheeler, "The Social Insects." 378 pp. New York: Harcourt, Brace and Co. 1928.

stitute higher education but the men to whose influence students are exposed.

There will always be scientists who prefer industrial research and the higher salaries that go with it, but if the university succeeds in remaining what it originally was, a Universitas Litterarum and an active center of independent research, it will continue to attract the best minds and need not be afraid of competition.

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SCIENCE TALENT IN AMERICAN YOUTH[1]

A RECENT note on the Science Talent Search states that "the methods which are being used, and the conclusions which are being derived, deserve the careful examination of every scientist and of every teacher of science," and that "the sponsors of the examination have an excellent opportunity to gain for science a quantity of data which may determine just what makes a scientist."[2] Such ideas have always been basic in the thinking, planning and operation of this annual competition for the Westinghouse Scholarships, conducted by Science Clubs of America and Science Service. The objectives are:

1. To discover and foster the education of boys and girls whose scientific skill, talent and ability indicate potential creative originality and warrant scholarships for their development.

2. To focus the attention of large numbers of scientifically gifted youth on the need for perfecting scientific and research skill and knowledge so that they can increase their capacity for contributing to the task of winning the war and the peace to follow.

3. To help make the American public aware of the role of science in war and in the post-war reconstruction.[3]

As has been pointed out on numerous occasions[4]—including one conference on the methods of the Science Talent Search attended by Mr. Brandwein—surveys are being made annually of the social, physical and professional development of all the entrants in the first and second contests. This includes detailed information on trip winners, honorable mentions and *non*-winners; similar surveys are being made of all winners in additional years. The resulting materials will be useful in tracing the growth of several thousand young people interested in science as a career, and will also supply significant data regarding selection procedures so that these can be improved if so indicated. As a hypothetical example, if it is found that a significant number of non-winners have made greater progress in science than winners and honorable mentions, it will mean that the factors or evidences on which selections are made in future years will be modified or weighted accordingly.

The 120 who placed highest in the first three contests have been above the average in their scientific studies and endeavors. We are confident that some of them will be great scientists in a creative sense; it is too much to expect that all will. The boy winner of the Westinghouse Grand Science Scholarship in the first year (1942), a recent Phi Beta Kappa, is now in medical school; and the top girl winner of the same year, also a Phi Beta Kappa, has been outstanding in her college career. It is too early yet to arrive at any general conclusions, especially considering the fact that at least 2,088 boys and 39 girls among the contestants in the first and second years are known to be in the military service. In fact, 44 of the 88 boy winners in the first three contests are now in the armed services.

The author of the critical note inquires whether non-winners might become successful scientists, "especially if they obtained the publicity and opportunities afforded the winner."[5] The only way to make a comparison of winners and non-winners and at the same time keep the variable of publicity approximately the same for both groups would be to give equal scholarships also to those who are *not* believed to be potential future scientists—of course keeping the basis of their selection unheralded and unsung—and then to compare the two groups over the years ahead. We wonder how acceptable such an idea would be to our leading colleges and technical schools; would they like to give financial scholarships for probable future scholarly attainment to students who it is thought will *not* be successful in their academic pursuits?

In the meantime we are obtaining a variety of information that may be useful in answering a question recently asked of Dr. Vannevar Bush by President Roosevelt: "Can an effective program be proposed for discovering and developing scientific talent in American youth so that the continuing future of scientific research in this country may be assured on a level comparable to what has been done during the war?"[6] Able young men traditionally have been selected for training at West Point and Annapolis in military

[1] The opinions or assertions contained herein are the private ones of the writers and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

[2] Paul F. Brandwein, SCIENCE, 101: 117, February 2, 1945.

[3] "Science and the Future," Washington, D. C., Science Service, 1943, 126; "Scientists of Tomorrow," Washington, D. C., Science Service, 1944, 134. Copies of these books, containing the essays of all trip winners in the Second and Third Annual Science Talent Searches may be obtained free of charge from Science Service, 1719 "N" St., N.W., Washington 6, D. C.

[4] Harold A. Edgerton and Steuart Henderson Britt, *American Scientist*, 1943, 31, 55–68, p. 67; SCIENCE, 99: 319–320, April 21, 1944; "Science and the Future," *op. cit.*, 114–115. Also, "Scientists of Tomorrow," *op. cit.*, 130.

[5] *Cf.* Brandwein, *op. cit.*

[6] SCIENCE, 100: 542, December 15, 1944.

careers. An attempt is now being made for the first time in our history also to locate and select a small number of capable young men and women each year who can be assisted in their training for scientific careers at colleges and technical schools of their own choice. In a technological world they, too, are an important adjunct to the wartime and peacetime strength of the our nation.

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SCIENTIFIC BOOKS

THE PRODUCTION OF ANTIBODIES

The Production of Antibodies. By F. F. BURNET, with the collaboration of M. FREEMAN, A. V. JACKSON and DORA BUSH. Melbourne: Macmillan and Company, Ltd. 1941. $2.50.

THIS short monograph of 76 pages is a noteworthy attempt to integrate modern concepts of biology, immunochemistry and protein chemistry toward the formulation of a realistic hypothesis of the *in vivo* synthesis of antibodies. Although published nearly four years ago, a belated review of this work hardly requires justification, since the ideas expressed by the authors have maintained their value and importance in the face of more recent discussions of this lively problem. Indeed, it appears that this monograph has escaped the attention it deserves, for recent reviews and monographs dealing with immunochemistry have either omitted mention of it or given only passing reference.

Following an introductory discussion of the general character of antibodies more biological aspects of their general immunological functions are reviewed in chapters II to V. These include considerations of the rate and extent of antibody formation in the blood of actively and passively immunized animals; of the evidence for qualitative differences among antibody molecules produced against the same antigen in a single animal; and of the qualitative changes in antibodies during prolonged immunization. Original experimental data are incorporated in the review of these problems, as well as in a comprehensive, yet concise discussion of the site of antibody production (chapter VI). The latter leads the authors to conclude that antibody is produced by the very phacogytic cells of the reticulo-endothelial system (spleen, liver, bone marrow, lymph nodes) which ingest the antigen. Although difficult to prove experimentally, the view is advanced that antibody production may continue in the absence of antigen, an argument which is fundamental to the general thesis which the authors finally propose. Chapter IX draws further factual and presumptive evidence, from considerations of the tuberculin type of sensitization to bacterial products, for the belief that the very reticulo-endothelial cells which are involved in disintegration of the antigens likewise are effective in antibody production.

In chapter X a theory of antibody production is developed, based on seven principal conclusions derived from the preceding discussion, and viewed in the light of modern concepts of protein structure and protein synthesis. The authors emphatically criticize the claims for reality of the Haurowitz-Mudd "template" theory, according to which antibody globulin is synthesized in direct spatial contact with the antigen molecule, resulting in the development of complementary patches to the determinant groups of the antigen. They deny any real physico-chemical basis for believing that simple juxtaposition of the growing globulin molecule to the antigen would result in the development of complementary pattern, particularly since the very argument has been used by virus workers, "to show that protein synthesized in contact with a pattern (virus protein) will produce not a complementary pattern but a replica of the original pattern."

In the author's hypothesis the Bergmann-Niemann concept of the dual proteolytic and protein-synthetic activity of intracellular enzymes occupies a central portion. However, instead of invoking an organizer to control the regular addition of amino acid residues or protein fragments, they consider the intracellular proteins to be endowed with enzymatic activity in such a way as to provide a pattern and a "scaffold" on which the new protein is constructed. Unlike the proteins of the extracellular secretions, these intracellular proteins are self-synthesizing according to their own pattern. Applying these ideas to the intracellular proteins of the reticulo-endothelial system, the thesis is developed that, in the absence of antigenic stimulus, normal globulins are produced by these cells and liberated eventually into the blood and lymph. However, upon contact with any foreign antigen, such modifications of the intracellular proteinases take place, simultaneously with the destruction of the antigenic particle, as is required for an effective hydrolytic action on the foreign antigen. This modification in structure and activity of the enzymes is believed to result in the synthesis of modified globulins (antibody) and to persist, even in the absence of further contacts with the antigen. Gradually, however, the original impression will be eliminated, regressively, and ultimately, normal globulin will again be produced. It is emphasized that these processes should not be considered to result merely from spatial con-

tact with the antigen but rather as an adaptive process analogous to that involved in the production of adaptive bacterial enzymes.

This general hypothesis provides a rational explanation for the formation of cross-reactive antibodies upon prolonged immunization with a single antigen: More extensive contact with the antigen enhances the opportunity for more intimate regions of the antigen to impress specific modifications on the proteinase system. Also, antigen fragments produced by the hydrolytic action of the proteinases may themselves impress their mark. Conversely, the formation of low-grade antibodies during the transition period of decreasing antibody titer may be assumed to occur as in the absence of further antigenic stimuli, the intracellular enzymes gradually return to their normal specificity.

It is obvious that a large part of the ideas expressed in this monograph is speculative and requires experimental testing. However, the general picture which the authors present is congruous and a rich source for thought on this stimulating problem.

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MUSHROOMS

Mushrooms of the Great Lakes Region. By VERNE OVID GRAHAM. Illustrated. Pp. vii + 390. Chicago Academy of Sciences and the Chicago Natural History Museum.

UNDER the title "Mushrooms of the Great Lakes Region" Verne Ovid Graham, honorary curator of mycology in the Chicago Academy of Sciences, has issued a volume on the higher fungi of that region. The title "Mushrooms" is a little misleading, for it is not strictly a mushroom book as that term is ordinarily used. It is rather a descriptive list of all the higher fungi, Ascomycetes and Basidiomycetes, known to occur in that region. Although it must necessarily be very incomplete, it will doubtless serve as an aid to students in identifying the more common species of fungi, the purpose for which it was evidently intended.

FRED J. SEAVER

SELECTED EXPERIMENTS IN CHEMISTRY

Selected Experiments from Laboratory Manual for Introductory College Chemistry. By J. A. BABOR and A. LEHRMAN. New York: Thomas Y. Crowell Company. 64 pages. 29 figs. 1944. $1.00.

THIS is a reprint of thirty-eight of the experiments which the authors first published in 1941. There is one new experiment on the preparation of copper, lead and antimony from their ores, and two new experiments on a qualitative analysis for thirteen cations. Teachers of accelerated courses desiring an abridged manual of the conventional experiments in general chemistry, with questions and problems to fill in and tear out, will find this edition handy.

HUBERT N. ALYEA
PRINCETON, N. J.

REPORTS

THE SOUTHERN RESEARCH INSTITUTE

IN March of this year the Southern Research Institute will begin an active research program in its laboratories in Birmingham. This is the culmination of years of study and preparation on the part of a number of southern industrialists who long have realized the importance of scientific research in the development of the economy of the southern part of the United States. In studying the need for research facilities in the South, it was found that although southern universities and colleges are well prepared for teaching the natural sciences and for undertaking certain fundamental research projects, generally there has been a deficiency in research facilities available for solving industrial problems on behalf of private enterprise.

The Alabama Research Institute was incorporated in 1941, and recently became the Southern Research Institute to conform more properly with its region-wide function. The institute is a non-profit corporation. Its purpose is to assist industry in creating new and improved products; to make research facilities available to existing establishments which do not have the equipment and specialized personnel to undertake the solution of their own technological problems; and to afford facilities to those industries which, although having well-equipped laboratories of their own, find it advantageous from time to time to have certain types of research work done in an atmosphere removed from the distractions incident to their own production problems.

On entering into a research agreement with the institute, the sponsor will set forth the objectives of the project and establish a fund for its prosecution. The institute will select from its staff suitably qualified personnel or employ research men specialized in a particular field who will be assigned to that research project. The sponsor of the project will pay into the institute a sum of money commensurate with the purpose of the investigation for the agreed period, and all salaries and expenses connected therewith and all spe-

cial equipment and services essential thereto will be paid from that fund. The agreement will stipulate the estimated cost of the undertaking, which will include an amount to be retained by the institute for overhead expenses. The sponsor of the undertaking will be kept informed as to the progress of the work and will be expected to lend active support to the program by making available to the institute special knowledge and experience relative to the undertaking at hand, and such specialized facilities as may be indicated to be of aid in the solution of the sponsor's research problem.

Any discoveries growing out of a sponsored investigation shall become the exclusive property of the project sponsor, and it will be incumbent on the institute to assign all rights, patents and titles to the sponsor. There may be an occasional exception in the application of this principle in cases where the investigation has originated in the institute or involves some special knowledge already acquired by the institute in its own researches. The institute is bound to complete secrecy as to the developments and will agree that no publication thereof shall be made for a stipulated period without consent of the sponsor. Although the Southern Research Institute has been established to provide new research facilities in the South, the acceptance of sponsored research projects will not be limited by any specific geographical considerations.

The Southern Research Institute now has in excess of $500,000 in capital, all contributed by business enterprises and persons in the southern states. In general the contributors are manufacturing enterprises to whom facilities and scientific skill will be available on a fee basis; trade and service establishments who will share in the region's expanded purchasing power; public utilities who inescapably feel the impact of generally higher economic attainments; agriculturists whose markets are likely to be broadened; trade and industrial associations who enjoy in common the benefits of increased basic knowledge of their mutual products; and finally those engaged in the professions whose welfare is dependent on that of the community at large.

For the duration of the emergency, the closest attention is being given to providing added research and testing facilities of interest to the war agencies and to aiding local manufacturers engaged in the production of war materials.

Current funds are sufficient to equip the institute and to insure operations for its initial period, or until the institute can be made self-supporting. As the scope of usefulness of the Southern Research Institute increases, further additions to the institute's capital funds will no doubt be needed. A genuine and substantial interest in research is spreading throughout the South which gives friends of the institute confidence that the necessary funds for a healthy growth will be forthcoming.

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SPECIAL ARTICLES

ROLE OF FAT IN INCISOR DEPIGMENTATION OF VITAMIN E–DEFICIENT RATS[1]

IT has been reported[2, 3] that the normally brown-yellow pigment of maxillary rat incisor teeth disappears when the animal suffers from vitamin E deficiency. Development of an orange-brown coloration in the adipose tissue of E-deficient rats has been shown by one of us[4] to depend on the presence of certain unsaturated fats in the diet. In order to investigate a possible relationship between such dietary fat and dental depigmentation, we established five groups of animals comprising 6 newly weaned rats, and reared them for 80 days on the following diets:

Group 1 (vitamin E deficient, fat free): Sugar 65 per cent.; casein, alcohol-extracted, 20 per cent.; dried yeast, ether-extracted, 10 per cent.; salt mixture no. 2, U.S.P., 5 per cent.; tetrasodium salt of 2-methyl-1,4-naphthohydroquinone diphosphoric acid, 1 mg; vitamin A and D concentrate in oleic acid, 2 drops weekly per animal corresponding to 560 i.u. A and more than 80 i.u. D. Group 2 (vitamin E containing, fat free): Same as group 1 plus 10 mg per cent. of d,l-alpha-tocopherol acetate. Group 3 (vitamin E deficient, high fat): Same as group 1 but with 20 per cent. sugar replaced by 20 per cent. cod liver oil. Group 4 (vitamin E containing, high fat): Same as group 3 plus 10 mg per cent. d,l-alpha-tocopherol acetate. Group 5 (normal control) was fed dog chow.

Degree of pigmentation was recorded weekly by comparison with a scale of colors, 1 to 10, 1 being the color of pigment-free mandibular incisors in just-weaned animals, 10 the brown-yellow color of pigmented maxillary incisors in normal adult animals.

Animals in groups 1, 2 and 4 developed incisor pigment essentially in the same way as group 5, color intensity increasing from 2.5 in maxillary incisors and from 1 in mandibular. In group 3, pigmentation of the maxillary incisor teeth occurred as in other

[1] Aided by grants of the Carnegie Corporation of New York, Eastman Dental Dispensary of Rochester, and Wyeth, Inc., Philadelphia.

[2] A. W. Davies and T. Moore, *Nature*, 147: 694, 1941.

[3] T. Moore, *Biochem. Jour.*, 37: 112, 1943.

[4] H. Dam, *Jour. Nutrition*, 27: 193, 1944.

groups until about the 20th day, when an abrupt disappearance of pigment was observed at the gingival margin. Thereafter, depigmented enamel progressively replaced pigmented enamel as the teeth erupted. All animals in group 3 had bluish-white incisor teeth after 45 days (indicated as 0 in Fig. 1), although a few retained small yellow areas on a depigmented background. Mandibular incisors of this group presented no significant deviation of pigmentation as compared with those of other groups. However, rats fed a similar diet for a greater length of time exhibited an irregular depigmentation of these teeth.[5] Fig. 1 shows changes of pigment observed in the five groups.

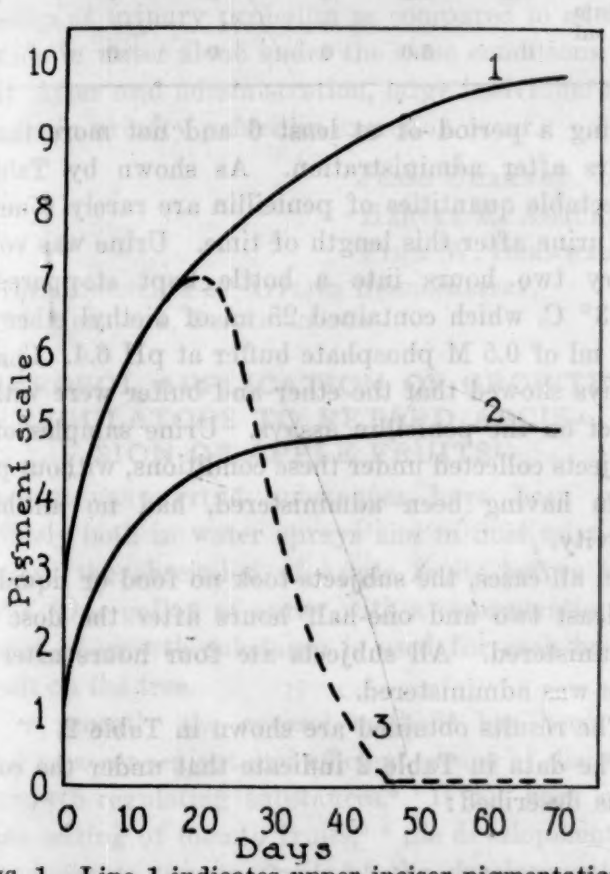

FIG. 1. Line 1 indicates upper incisor pigmentation in groups 1, 2, 4 and 5. Line 2 represents lower incisor pigmentation of all 5 groups. Line 3 shows upper incisor pigmentation of group 3.

No particular differences in eruption and attrition of incisor teeth were found in animals of the first four groups, but in group 5 these processes took place at a somewhat higher rate. Depigmentation was not correlated with any change in the rate of eruption and attrition. The average weight at the end of the experiment was slightly higher in groups 4 (194 g) and 5 (205 g) than in preceding groups (142, 153 and 160 g). Scaly tail developed in all animals on fat-free diets (1, 2). Autopsy revealed brown coloration of adipose tissue only in group 3, confirming previous observations.

[5] H. Granados, K. E. Mason and H. Dam, *Jour. Dental Research* (Proc. 23rd General Meeting International Association for Dental Research), 1945.

These results indicate that depigmentation of incisors in vitamin E-deficient rats requires the presence of fat, presumably unsaturated fatty acids, in the diet, a finding which suggests that the phenomenon is related to some abnormal deposition or reaction of fat in the ameloblasts. A previous observation[6] of persistence of dental pigment in rats reared on an E-deficient diet for 167 days can not be compared with our findings, due to the fact that the diet used was not reported. It is possible that this contradictory finding could be explained by differences in dietary fat content.

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URINARY EXCRETION OF PENICILLIN IN MAN AFTER ORAL ADMINISTRATION WITH GASTRIC ANTACIDS[1]

WHEN given by mouth, penicillin is reported to be destroyed by stomach acid.[2, 3] In subjects suffering from achlorhydria, penicillin is absorbed into the blood after oral administration.[3] Penicillin has been detected in the blood when given by mouth together with sodium bicarbonate.[3] Urine recoveries of intravenously and intramuscularly injected penicillin are reported to average approximately 60 per cent.[4]

These reports suggested to one of us (H.E.A.) that neutralization of gastric acidity might permit the absorption of a significant quantity of penicillin when the drug was given by mouth.

In our first series of experiments, approximately 20,000 units of penicillin in 200 ml of solution containing the antacid to be tested were given by mouth two hours after the morning meal. The percentages of the dose excreted in the urine during each two-hour period thereafter were estimated turbidimetrically using *Staphylococcus aureus* 6538 as the test organism. The unknown samples were compared with standard penicillin curves which were prepared in duplicate each day.

It was found that when penicillin was administered by mouth alone under these conditions, no more than 3 per cent. of the dose was recovered.

When 5 gm trisodium citrate ($Na_3C_6H_5O_7 \cdot 5\frac{1}{2}\ H_2O$)

[6] J. T. Irving, *Nature*, 150: 122, 1942.

[1] This manuscript was submitted for publication in SCIENCE under date of December 9, 1944.

We wish to thank Mr. S. M. Mann, head of the Microbiological Department of the Wyeth Institute of Applied Biochemistry, for making possible the penicillin assays, and Miss Anne Ospeck for carrying out the assays.

[2] C. H. Rammelkamp and C. S. Keefer, *Jour. Clin. Invest.*, 22: 425, 1943.

[3] C. H. Rammelkamp and J. D. Helm, Jr., *Proc. Soc. Exp. Biol. and Med.*, 54: 324, 1943.

[4] C. H. Rammelkamp and S. E. Bradley, *Proc. Soc. Exp. Biol. and Med.*, 53: 30, 1943.

TABLE 1

URINARY EXCRETION OF PENICILLIN AFTER ORAL ADMINISTRATION

Subject	Date	Conditions of penicillin administration	Percentage of dose excreted Hours after oral administration					Total recovery
			2	4	6	8	10	
								Per cent.
F.B.E.	4/20/44	32,000 units in 100 ml distilled water	2.2	0	0	0	0	2.2
J.C.	5/16/44	20,000 units plus 5 gm trisodium citrate in 200 ml distilled water.	11.4	6.1	1.8	0	0	19.3
F.W.B.	8/8/44	111,000 units plus 5 gm trisodium citrate in 200 ml distilled water.	13.6	6.7	0.6	0	0	20.9
F.B.E.	3/16/44	22,000 units plus 2.5 gm disodium phosphate in 200 ml distilled water.	12.7	4.9	1.6	0.7	0	19.9
R.T.	7/24/44	24,000 units plus 3 gm sodium bicarbonate in 200 ml distilled water.	5.3	1.5	0	0	0	6.8
H.E.A.	2/1/44	20,000 units plus 20 ml Amphojel (hydrous alumina) in 200 ml distilled water.	11.5	3.1	0.9	0	0	15.5
J.C.	8/8/44	28,000 units in 200 ml milk plus 5 gm calcium carbonate.	6.2	1.2	0	0	0	7.4
J.C.	8/17/44	20,000 units plus 1.0 gm magnesium oxide plus 20 ml Amphojel in 200 ml distilled water.	0	5.0	0	0	0	5.0

were given simultaneously with penicillin, an average of 18 per cent. of the dose was recovered in the urine in twenty-one trials. Occasional recoveries of over 25 per cent. were obtained. Of the amount recovered, an average of 70 per cent. was excreted in the first two hours.

Disodium phosphate ($Na_2HPO_4 \cdot 12\ H_2O$), (2 to 10 gm) was also tested with comparable results. The average recovery of penicillin in five trials was 18 per per cent. In our tests with sodium bicarbonate recoveries ranged from 3 per cent. to 10 per cent. Solid or colloidal antacids such a hydrous alumina, and milk with calcium carbonate were also used.

The results of representative experiments are tabulated in Table 1.

Following these preliminary results, a study was made of some factors affecting urinary excretion of penicillin. In order to obtain data on a greater number of subjects, we determined only total excretion during a period of at least 6 and not more than 8 hours after administration. As shown by Table 1 detectable quantities of penicillin are rarely found in the urine after this length of time. Urine was voided every two hours into a bottle kept stoppered at 0°–3° C. which contained 25 ml of diethyl ether and 100 ml of 0.5 M phosphate buffer at pH 6.4. Control assays showed that the ether and buffer were without effect on the penicillin assays. Urine samples of 10 subjects collected under these conditions, without penicillin having been administered, had no antibiotic activity.

In all cases, the subjects took no food or liquid for at least two and one-half hours after the dose was administered. All subjects ate four hours after the dose was administered.

The results obtained are shown in Table 2.

The data in Table 2 indicate that under the conditions described:

TABLE 2

No. of subjects	Total No. determinations	Conditions of Penicillin administration (Approximately 25,000 units)	Percentage of dose excreted in 6–8 hours	
			Average	Range
13	25	400 cc water, after overnight fast.	12.8	4.2–23.3
5	5	400 cc water plus 0.5 gm disodium phosphate, after overnight fast.	11.8	7.1–16.6
5	5	400 cc water plus 2.5 gm disodium phosphate, after overnight fast.	19.4	13.6–27.2
5	5	400 cc water plus 5.0 gm disodium phosphate, after overnight fast.	10.1	4.9–14.4
6	6	400 cc water plus 0.3 gm trisodium citrate, after overnight fast.	11.9	8.0–21.0
6	6	400 cc water plus 1.4 gm trisodium citrate, after overnight fast.	15.6	6.6–32.5
6	6	400 cc water plus 2.8 gm trisodium citrate, after overnight fast.	16.8	8.4–26.4
6	6	400 cc water plus 7.0 gm trisodium citrate, after overnight fast.	13.9	9.2–18.5
9	15	400 cc water, two hours after breakfast.	5.0	0.0–10.5
6	6	400 cc water plus 0.3 gm trisodium citrate, two hours after breakfast.	6.9	0.0–20.5
6	6	400 cc water plus 1.4 gm trisodium citrate, two hours after breakfast.	10.6	1.7–16.9
6	6	400 cc water plus 2.8 gm trisodium citrate, two hours after breakfast.	10.6	5.6–16.2
6	6	400 cc water plus 7.0 gm trisodium citrate, two hours after breakfast.	11.2	8.2–14.4

(1) Less penicillin is excreted when administered in water two hours after breakfast than when administered in water after an overnight fast. This is probably due to decreased gastric acidity in fasting subjects.

(2) Administration of 1.4 to 7.0 gm of trisodium citrate or 2.5 gm disodium phosphate with penicillin after an overnight fast slightly increases the urinary excretion of penicillin over values obtained after administration of penicillin in water alone under the same conditions.

(3) Administration of 1.4 to 7.0 gm of trisodium citrate with penicillin two hours after breakfast, results in approximately a 100 per cent. increase in excretion of urinary penicillin as compared to administration in water alone under the same conditions.

(4) After oral administration, large individual differences in urinary penicillin excretion occur.

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AEROSOL APPLICATION OF GROWTH REGULATORS TO RETARD ABCISSION OF APPLE FRUITS[1]

GROWTH-REGULATING substances have been used effectively both in water sprays and in dust mixtures to retard the abscission of apple fruits before harvest.[2,3] One gallon of spray with a concentration of 10 ppm of growth substance is used for each bushel of fruit on the tree.

More recently the aerosol method[4] has been reported as a convenient and efficient means of dispensing growth-regulating substances.[5] It has been used for the setting of tomato fruits,[5,6] the development of parthenocarpic tomato fruits,[5,6] the development of blackberry fruits[7] and the destruction of weeds.[8] It is more like a fumigation than a spray and avoids the use of water or dust carrier. The growth substance and a carrier solvent are held under pressure dissolved in a liquefied gas. The mixture is released as a very fine mist. The liquefied gas escapes and carries with it the growth-regulating substance and the solvent. The vapor pressure of the gas is sufficient to disperse the solution into very small particles.

Because of the large size of commercial apple trees and the rapid diffusion and drifting of an unconfined gas, the use of the aerosol method with present equipment in large commercial orchard operations has been considered impracticable. However, its use with small trees suggests itself as a possibility. This paper reports results with growth-regulating substances applied in aerosol form to dwarf and semi-dwarf apple trees for the prevention of pre-harvest drop of fruit.

An aerosol was prepared consisting of .25 per cent. naphthalene acetic acid, .5 per cent. lanolin and 94.75 per cent. dimethyl ether.[5] In addition, for comparison, two water sprays were prepared with naphthalene actic acid at 10 ppm, using .5 per cent. ethyl alcohol as the carrier for the growth-regulating substance for the one spray and .5 per cent. Carbowax 1500 for the other.[9]

Eight- and nine-year-old trees of the McIntosh, Macoun and Kendall varieties were selected for treatment—12 trees of the first and 6 trees of each of the other two. They are varieties which do not retain the fruit well and also which are not overly responsive to the pre-harvest spray. They were on dwarf (Malling IX) and semi-dwarf (Malling I, V and VII) rootstocks. The dwarf trees were 5½ feet in height, 6 feet in spread and averaged about 1 bushel of fruit per tree. The semi-dwarf trees were approximately 12½ feet in height, 10 feet in spread and averaged about 2.5 bushels of fruit per tree.

Initial applications were made on September 18 at the time considered most likely to be effective, and repeated at 7-day intervals on September 25, October 3 and October 10. The aerosol was applied by means of a "Sure Shot Pressure Sprayer" weighing about 2 pounds, and the water spray from a 3-gallon knapsack sprayer. Applications were made during the more quiet part of the day, as early forenoon or late afternoon. Because of the small size of the trees and the accessibility of the fruit, it was possible to apply both the aerosol and the water sprays directly at the fruit from a distance of only a few feet. Average mean temperatures on the days of application were 69° F. September 18, 54° F. September 25, 58° F. October 2 and 55° F. October 10.

Approximately 1/3 (.34) of a gallon of water spray was used for each bushel of fruit, and ½ ounce (.034 of a pound) of aerosol for each bushel of fruit. In terms of growth-regulating substance, 13.8 mgs of naphthalene acetic acid were used per bushel of fruit in the water spray and 34 mgs in the aerosol. This compares with the recommended commercial prac-

[1] Journal article No. 615 of the New York State Agricultural Experiment Station.

[2] F. E. Gardner, P. C. Marth and L. P. Batjer, *Proc. Amer. Soc. Hort. Sci.*, 38: 104–110, 1941.

[3] M. B. Hoffman, A. VanDoren and L. J. Edgerton, *Proc. Amer. Soc. Hort. Sci.*, 203–206, 1943.

[4] Lyle D. Goodhue, *Indust. and Eng. Chem.*, 34: 1456–1459, 1942.

[5] C. L. Hamner, H. A. Schomer and L. D. Goodhue, SCIENCE, 99: 85, 1944.

[6] P. W. Zimmerman and A. E. Hitchcock, *Contrib. Boyce Thompson Inst.*, 13(7): 313–322, July–Sept., 1944.

[7] P. C. Marth and E. M. Meader, *Proc. Amer. Soc. Hort. Sci.*, 45: 293–299, 1944.

[8] C. L. Hamner and H. B. Tukey, *Bot. Gaz.*, 106: 232–245, 1944.

[9] J. W. Mitchell and C. L. Hamner, *Bot. Gaz.*, 105: 474–483, 1944.

tice of 40 mgs where 1 gallon at 10 ppm is used for each bushel of fruit.

All the treatments proved effective in delaying the abscission of the fruit. With the McIntosh variety, the percentages of fruit remaining on the trees on October 12 (22 days after commercial harvest) were:

Carbowax-water spray	78 per cent.
Aerosol	75 per cent.
Alcohol-water spray	74 per cent.
Control	36 per cent.

On October 30 (41 days after commercial harvest), 12 per cent. of the fruit still remained on the trees, whereas on the untreated trees no fruit remained.

With the Macoun variety the results were similar. Fifty-six per cent. of the crop remained on the aerosol-treated trees on October 17 (22 days after commercial harvest) compared with 33 per cent. on untreated trees; and on October 31 (36 days after commercial harvest) 27 per cent. of the fruit remained on treated trees as compared with 4 per cent. on untreated trees. The most striking results were obtained with the Kendall variety—87 per cent. of the fruits remaining on the treated trees on October 30 (35 days after commercial harvest) as compared with 2 per cent. on untreated trees. In fact, many of the fruits which remained were cracked and split due to continued growth.

No attempt was made to be economical with material in the aerosol treatment; the cylinder was exhausted at each application. It may be that the amount was in excess of what was needed. Nevertheless, even at the relatively high concentration of 40 mgs of growth-regulating substance per bushel of fruit, as used in commercial orchard spraying, 1 pound of aerosol containing ¼ per cent. of growth-regulating substance is equivalent to 28¼ gallons of water spray containing 10 ppm of growth substance.

The efficiency and ease of application by the aerosol method suggests the possibility of applying other materials by the same method, such as insecticides and fungicides,[6] at least to small trees, and of developing special equipment for application to large trees. The effectiveness of repeated applications at 7-day intervals is of interest in this connection.

An aerosol of 2–4 dichlorophenoxyacetic acid was also effective in delaying the abscission of the fruit. Not only did the fruits adhere tenaciously for a long period but they were more highly and more completely colored—especially those fruits which were in close proximity to the point of aerosol application. There may be other materials as well, which may prove useful in aerosol form for the prevention of pre-harvest drop of fruit.

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EFFECT OF MERTHIOLATE (LILLY) ON CERTAIN SPECIFIC PRECIPITATION REACTIONS[1]

THE use of Merthiolate (Lilly) as a preservative for blood serum is a general practice.[2] Since Merthiolate (Lilly) is sodium ethylmercurithiosalicylate ($C_2H_5HgSC_6H_4COONa$), a substituted benzoic acid, and would be expected to combine with antibenzoic acid serum, we have tested this possibility. Quantitative determinations were made of the effect of this compound on the precipitation by two antigens of antiserum (anti-X serum) obtained from rabbits inoculated with beef serum coupled with diazotized *p*-aminobenzoic acid. The precipitating antigens used were 1,8-dihydroxy-2,7-di(*p*-(*p*-azophenylazo) benzoic acid)-3,6-disulfonic acid naphthalene (Chrom X′$_2$) and ovalbumin coupled with diazotized *p*-amino benzoic acid (X-ovalbumin). Determinations were also made of the effect of Merthiolate (Lilly) on the specific precipitation of antisera obtained from rabbits inoculated with sheep serum coupled with *p*-arsanilic acid (anti-R serum) or with sheep serum coupled with diazotized *p*-(*p*-aminophenylazo)phenylarsonic acid (anti-R′ serum). The following antigens were used: 1,8-dihydroxy-2,7-di(*p*-azophenylarsonic acid)-3,6-disulfonic acid naphthalene (antigen XXXI); 1,8-dihydroxy-2,7-di(*p*-(*p*-azophenylazo)phenylarsonic acid)-3,6-disulfonic acid naphthalene (antigen XXX); and ovalbumin coupled with diazotized *p*-(*p*-aminophenylazo)phenylarsonic acid (R′-ovalbumin).

Evidence of interaction of antibody and Merthiolate (Lilly) was observed in several of these systems.

EXPERIMENTAL METHODS

Materials: The antisera and antigens have been described previously.[3,4,5]

The Reaction of Antiserum with Antigen and Merthiolate (Lilly): The reaction mixtures were set up in triplicate, with use in each series of experiments of the amount of antigen giving the largest amount of precipitate in the absence of hapten; borate buffer was used as diluent.[6] The tubes were allowed to stand one hour at room temperature and overnight in the refrigerator, and the precipitates were then analyzed by our usual method.[7]

The final concentrations of Merthiolate (Lilly) in the precipitating mixtures covered the range usually

[1] Contribution from the Gates and Crellin Laboratories of Chemistry, California Institute of Technology, No. 962.

[2] W. C. Boyd, "Fundamentals of Immunology." Interscience Publishers, Inc., New York, 1943, p. 342.

[3] L. Pauling, D. Pressman, D. H. Campbell, C. Ikeda and M. Ikawa, *Jour. Am. Chem Soc.*, 64: 2994, 1942.

[4] D. Pressman, J. T. Maynard, A. L. Grossberg and L. Pauling, *ibid.*, 65: 728, 1943.

[5] D. Pressman, S. M. Swingle, A. L. Grossberg and L. Pauling, *ibid.*, 66: 1731, 1944.

[6] D. Pressman, D. H. Brown and L. Pauling, *Jour. Am. Chem. Soc.*, 64: 3015, 1942.

[7] D. Pressman, *Ind. Eng. Chem., Anal. Ed.*, 15: 357, 1943.

used for preservation, *i.e.*, 1/5,000 to 1/15,000. The results are in Table 1.

DISCUSSION

In Systems 4 and 5, Table 1, Merthiolate (Lilly) in the concentrations used had an essentially negligible effect on the amount of precipitate. However, in Systems 2, 6, and 7 Merthiolate (Lilly) caused appreciable inhibition of precipitation, while in Systems 1 and 3 there were appreciable increases in the amounts of precipitate. The decrease in System 6 and the increase in System 3 definitely demonstrate that Merthiolate (Lilly) interacts with the antibody, since the same antigen was used in both experiments.

The effect of the hapten on the precipitation of the homologous serum, *i.e.*, anti-X serum, was to increase precipitation when Chrom X'_2 was used as the antigen (System 1) and to decrease precipitation when X-ovalbumin was used (System 2). The phenomenon of increased precipitation of anti-X serum with Chrom X'_2 caused by benzoic acids with large groups in the ortho position has been demonstrated previously.[5]

Others of our experiments (unpublished) have shown that precipitation of anti-R serum may be increased by negatively charged haptens other than arsonic acids, as is evidenced here also (System 3). It is interesting that maximum inhibition was observed with anti-R′ serum. This may well be due to the same phenomenon that has been discussed previously,[4] *i.e.*, looseness of fit of this antibody with hapten and antigen.

TABLE 1

EFFECT OF MERTHIOLATE (LILLY) ON SPECIFIC PRECIPITATION

Antisermu and borate buffer. Volumes as indicated; antigen solution, 1 ml; Merthiolate (Lilly) solution, 1 ml; pH of supernates, 8.1.

	Antiserum used		Antigen used		Vol. Buffer used	Moles of Merthiolate (Lilly)[a] added X 10^9			
	Type	Vol. ml	Type	Wt. µg	ml	0	550	1650	4950
						Amount of precipitate, µg[b]			
1	Anti-X	0.75	Chrom-X'_2	55.5	0.25	(441)	(364)	(542)	(583)
2	Anti-X	.33	X-ovalbumin	172.	.67	1148	(1104)	[1022]	766
3	Anti-R	.25	XXX	22.2	.75	733	870	(926)	(900)
4	Anti-R	.125	R′-ovalbumin	87.	.875	414	412	410	382
5	Anti-R	.50	XXXI	25.0	.50	456	480	472	452
6	Anti-R′	.50	XXX	29.4	.50	229	169	(98)	62
7	Anti-R′	.25	R′-ovalbumin	131.	.75	173	(158)	(98)	78

[a] These amounts correspond to final Merthiolate (Lilly) concentrations of 0, 1/13,500, 1/4,500, 1/1,500, respectively.
[b] Values for precipitates with azoproteins include precipitated antigen protein. Values are averages of triplicate analyses with mean deviation of ± 3 per cent.; duplicate analyses in parentheses, single analyses in brackets.

This work was carried out with the aid of a grant from the Rockefeller Foundation.

SUMMARY

Merthiolate (Lilly), a substituted benzoic acid, has been shown to interfere, in concentrations usually used for preservation, with the specific precipitation of antisera against beef serum or sheep serum coupled with diazotized *p*-aminobenzoic acid, *p*-arsanilic acid, or *p*-(*p*-aminophenylazo)phenylarsonic acid. In some systems increased precipitation was observed, while in others decreased precipitation was observed.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A STRAIN GAGE RECORDER FOR PHYSIOLOGICAL VOLUME, PRESSURE AND DEFORMATION MEASUREMENTS

To measure and record the variety of pressure and volume changes encountered in physiological research, electrical means are particularly suitable, since they permit a combination of high fidelity of response, a wide variety of sensitivities, flexibility of experimental arrangement and instantaneous visualization of the phenomena to be recorded. Practically all known methods of converting mechanical into electrical energy have been utilized to obtain electrical records of pressure or volume changes or of mechanical deformations. The present report describes a new type.

The resistance wire strain gage, which is becoming increasingly useful in many industrial applications, has been found by us to be particularly suitable for electrical recording of plethysmographic and manometric measurements in physiology. The strain gage is a fine wire which undergoes resistive changes during stretch. In our physiological applications, the strain gage is mounted in conjunction with a volume or pressure capsule provided with a rubber or metal membrane. The gage is made one arm of a Wheatstone bridge. A deformation of the membrane of the capsule is transmitted to the wire and causes a resistive change in the gage. This produces an imbalance

voltage in the bridge. After suitable amplification, the imbalance voltage activates a direct writing instrument, such as the GE Photoelectric Recorder or an ink-writer of the type used in electroencephalography.

The block diagram of Fig. 1 shows the general

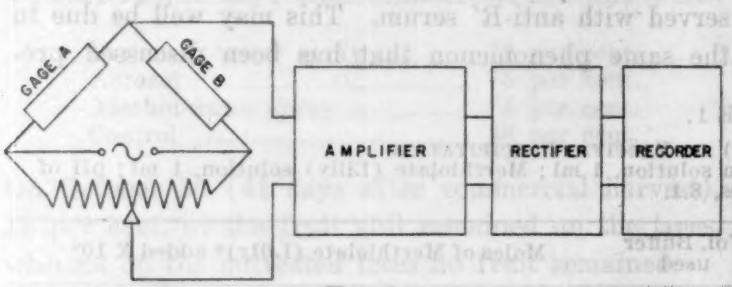

FIG. 1.

arrangement of the apparatus. The amplifier used in our present recorder is specially designed for extremely high sensitivity, low noise and low drift. These design features make the recorder useful in measuring and recording phenomena which are to be observed over a period of many hours.

A sample of direct ink records made with this recorder and the GE Photoelectric Recorder is shown in Fig. 2. The record represents the finger pulse

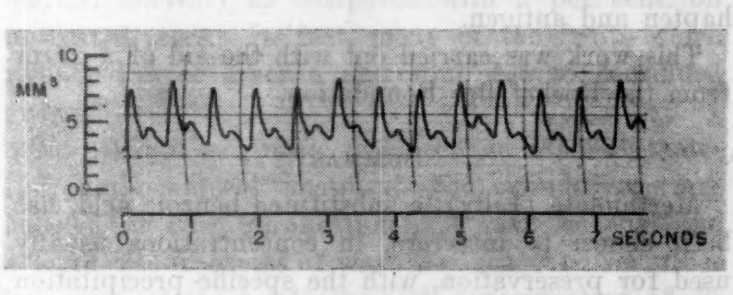

FIG. 2.

volume of the first phalanx of a human finger.

Simple modifications of the equipment make possible electrical recording of blood pressure, arterial pulse, muscle movements and other physiological variables. The sensitivity and stability of the amplifier have also proved useful in engineering applications of the strain gage.

The strain gage recorder was developed by the authors while they were senior physiologist, associate electrical engineer and senior pharmacologist, respectively, at the Climatic Research Unit, Fort Monmouth Signal Laboratory. It has been employed for about six months in the investigations of that Unit.

A full description of the strain gage recorder and of its various physiological applications will be published in an engineering memorandum of the Climatic Research Unit.

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A MODIFIED TECHNIQUE FOR READING THE RAPID SLIDE AGGLUTINATION OF LEPTOSPIRA

CONSIDERABLE difficulty has been experienced by the author in reading weak (1+ or 2+) reactions in the macroscopic agglutination test for Leptospirosis.[1] The antigen often forms an amorphous precipitate that seriously interferes with the accurate reading of these weak reactions.

In an effort to alleviate this difficulty it was decided to check each dilution with a modified dark-field technique similar to that used in the test-tube agglutination method for Leptospirosis.

The ordinary Abbe condenser is used in combination with a metallic dark-field stop placed in the slot provided beneath the Abbe condenser. Any light source may be utilized. A small drop of each dilution of the test is placed on a slide and examined, without a coverglass, under the low power objective. The condenser is then adjusted so that the organisms appear brilliant in the dark field.

This method clearly demonstrates the slightest clumping or agglutination. A strong positive reaction shows large definite clumps of organisms with a clear background. A weak positive reaction shows smaller clumps of organisms with a few individual organisms in the field. A negative reaction shows a homogeneous field of individual organisms. In all cases artifacts or precipitates appear as distinct brightly illuminated particles easily distinguishable from clumps of organisms.

In order to become familiar with the appearance of these reactions, it is advisable to make dilutions of known positive and negative sera and examine them in this manner.

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[1] Using Leptospira Diagnostic Antigen marketed by Lederle Laboratories, Inc., 30 Rockefeller Plaza, New York, N. Y.

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